

Feature Story



On the north flank of Redoubt Volcano, Cook Inlet, Alaska, USGS scientists measure the growing lava dome during 1989-90 eruptive activity. Damage and loss of revenue from volcanic ash and debris flows generated by these eruptions exceeded \$100 million.

Pat Jorgenson

With volcanoes erupting across the United States—in a series of big-screen and made-for-TV movies that recently debuted—American audiences may begin to wonder what is being done to reduce the risk of a real-world disaster the next time an eruption threatens local communities.

Plenty, say USGS volcanologists who have worked at some of the world's most dangerous volcanoes. "Volcanic eruptions have tremendous potential for destruction, but we are learning how to reduce the risk through research, planning, and public education," said **Robert Tilling**, chief of the USGS Volcano Hazards Team in Menlo Park, California.



Perilous Beauty

Serene looking Mount Rainier is considered the most dangerous volcano in the nation because of the large scale development that has sprung up around it's base. A team of USGS scientists worked in cooperation with the National Park Service to produce *Perilous Beauty: The Hidden Dangers of Mount Rainier*, a powerful education video on the potential hazards to the communities and businesses that are located in river valleys leading from the mountain. Public Broadcasting Station KCTS in Tacoma, Washington, aired the video on February 1 as a public service to the Seattle community, and will air it five more times before March 19. It is available to the public at Visitor Centers in Mount Rainier National Park and the Mount St. Helens National Volcanic Monument. It can also be ordered by mail or phone from: Northwest Interpretive Association, 909 First Avenue, Suite 630, Seattle, WA, 98104 (206) 220-4141 (voice) (206) 220-4143 (fax). *Perilous Beauty* costs \$19.95, plus postage.

Starting at Mount St. Helens in 1980 and continuing to the present day, USGS scientists have responded to dozens of volcano crises in the United States and around the globe. By assessing the hazards of future eruptions based on a volcano's past behavior, carefully monitoring for signs of restlessness, and keeping public officials informed of the dangers, scientists have helped to save thousands of lives and millions of dollars worth of property throughout the world.

Tilling noted that not all hazards from eruptions are limited to the immediate vicinity of the volcano. Huge debris avalanches and associated volcanic mudflows, such as those at Mount St. Helens in 1980, can travel tens of miles down valleys surrounding a volcano.

"In some cases, it may be safer to be closer to an erupting volcano and on high ground than it is to be farther away and on the floor of a valley," said **Dan Dzurisin**, scientist-in-charge at the USGS Cascades Volcano Observatory in Vancouver, Washington.

"For most volcanoes in the conterminous western United States, we've identified the areas likely to be threatened by future eruptions on hazard-zone maps, which provide a basis for long-range planning. The best way to minimize the effects of an eruption, after all, is to incorporate information about the risks in land-use planning—avoid high-density development in hazardous volcanic areas."

Hazards as High as Jet Aircraft Fly

Plumes of volcanic ash, shot high into the atmosphere, produce more far-reaching hazards than avalanches and mudflows. Ash clouds can damage or even bring down an airliner hundreds of miles from an erupting volcano. This has become a serious problem in recent years as air traffic through some of the world's worst "volcano shooting galleries" has increased dramatically.

"A prime example is our own Aleutian volcanic chain in Alaska," said **Terry Keith**, scientist-in-charge at the Alaska Volcano Observatory, a facility jointly operated by the USGS, Fairbanks Geophysical Institute of the University of Alaska, and Alaska Division of Geological and Geophysical Surveys. Every day, dozens of planes fly over or near some of the Aleutian's most active volcanoes.

In 1989, a Boeing 747-400 aircraft descended into what appeared to be a thin haze layer while on approach to Anchorage International Airport. In fact, the "haze" was volcanic ash from a small eruption of nearby Redoubt volcano. The jumbo jet lost power from all four engines for several agonizing minutes before the crew was able to restart them and land safely. Although no one was injured, the plane received about \$80 million in damage.

To avoid such costly and potentially deadly encounters in the future, the USGS, Federal Aviation Administration, and National Weather Service are working with similar agencies around the world to provide timely warnings of dangerous ash plumes. "Last year, we installed monitoring equipment on four additional volcanoes in the Aleutians, and this year we'll start monitoring four more," said Keith.

In addition to blasts, avalanche and debris flows, and ash clouds, hazards from an erupting volcano include poisonous gases, ashfall, lava flows, and pyroclastic flows—one of the most awesome volcanic hazards. During explosive eruptions, an avalanche of superheated ash, pumice, rock fragments and gas can pour out of the crater and sweep down the mountain's flank at more than 100 miles per hour, destroying everything in its path.

"By studying a volcano's eruptive history, we can get a pretty good idea of which hazards pose the greatest risks," said USGS researcher **Kevin Scott**. "At Mount Rainier, for example, we know that debris flows have repeatedly buried all of the valleys surrounding the volcano during the past few thousand years, and they will continue to do so in the future."

In recent years, USGS scientists have focused their attention on the volcano's history of debris flows and on mapping its ice-covered cone. Scott noted that an important difference between the last giant debris flow that swept down Mount Rainier's western slopes about 500 years ago and the one that could happen in the near future is the large number of people who now would be at risk.

Hawaiian Fire and VOG

Some of the most dramatic scenes of volcanic eruptions and those that most often come to the minds of Americans are the spurting lava fountains and red-hot lava streams of Hawaii. Although they are spectacular and destroy everything in their path, few lives are lost to these types of eruptions, because there is usually time for people to safely evacuate when threatened by an advancing flow.

On the Island of Hawaii, in fact, where Kilauea volcano has been erupting almost continuously since 1983, the eruption has destroyed 185 residences and other structures for a loss of \$ 61 million, yet only one person has lost his life.

"Deadly explosive eruptions can occur in Hawaii, but they are infrequent, said **Don Swanson**, scientist-in-charge at the USGS Hawaiian Volcano Observatory. "We take advantage of the volcano's frequent but usually safe eruptions to learn as much as we can about how volcanoes work, so we can apply what we learn to other, less friendly and cooperative volcanoes. But we also have some unique volcano-related health hazards to deal with here.

"Lava flowing into the ocean triggers a chemical reaction that produces a noxious brew known as 'vog' or volcanic smog," Swanson explained. "Medical researchers have documented deleterious human health effects of exposure to vog and other volcanic gas, and we volcanologists have recognized the need to work with chemists and meteorologists to better understand the phenomenon."

USGS volcanologists also are keeping a close eye on other potentially active volcanic systems, including Yellowstone caldera in Wyoming and the Long Valley-Inyo-Mono volcanic chain at the base of the Sierra Nevada of eastern California.

Just one week after the devastating eruption of Mount St. Helens on May 18, 1980, the Long Valley area was rocked by four magnitude-6 earthquakes within 48 hours and thousands of smaller ones over the next several weeks.

Over the last 16 years, Long Valley has been one of the more restless volcanic systems in the world. "Since 1980, an area near the town of Mammoth Lakes has experienced thousands of small earthquakes, uplift of the ground by as much as two feet, and increased fumarolic (smoke and gas) activity," said **David Hill**, USGS scientist-in-charge for Long Valley.

A swarm of earthquakes beneath Mammoth Mountain in 1989 accompanied an intrusion of magma beneath the volcano that failed to make it to the surface, but got close enough for carbon dioxide gas released from the magma to kill trees in the area.

This June 12, 1991, eruption of Mount Pinatubo, photographed from Clark Air Force Base in the Philippines, was the first in a series of powerful explosive eruptions which culminated on June 15 in the largest eruption of the last 80 years.

The U.S. Eruption Forecast

So, with all the media hype focused on erupting volcanoes, what are the odds that an eruption will occur anytime soon? In Hawaii, there's no clear end in sight to the eruption that started in 1983—it might continue for years or even decades.

The remote volcanoes of the Aleutian chain in Alaska typically produce two or more eruptions every year, posing a significant threat to aviation safety.

The Cascade volcanoes of Washington, Oregon, and northern California produce an average of one to two eruptions per century, but here the risk is larger owing to the greater population density.

The USGS volcanologists' best advice is to enjoy the season's volcano movies for their entertainment value, but keep in mind that real eruptions are serious business. By staying informed, you can significantly reduce your risk from future eruptions.

If you think your community could be threatened by a volcanic eruption, contact the USGS to determine if you are within a volcano hazard zone, learn more about volcano hazards from some of the sources listed below, find out what emergency plans have been made by your community, and develop a contingency plan for you and your family.

"Enjoy the movies," said Tilling, "but remember that natural processes like volcanic eruptions only



Above at a seismic station eight kilometers north of Mount St. Helens, Washington, the USGS continues to monitor volcanic activity. More than a million people visit the Mount St. Helens National Volcanic Monument each year.

At left, a USGS scientist installs a telemetered Global Positioning System site on the summit of Augustine Volcano, Cook Inlet, Alaska. Data from this and two other GPS sites on the volcano are sent via radio 110 kilometers to Homer, Alaska, where data are logged and periodically downloaded for analysis. The last eruption from Augustine occurred in 1986.

turn into natural disasters when humans get in the way. We can live in harmony with our active volcanoes, but only if we respect their power and plan accordingly."

From her office in Menlo Park, California, Pat Jorgenson handles outreach for the USGS Western Region.

The Hot Squad

John Ewert

The world's only volcano crisis response team is operated by the U.S. Geological Survey as part of the Volcano Disaster Assistance Program. Formed in cooperation with the Office of Foreign Disaster Assistance following the 1985 eruption of Nevado del Ruiz Volcano, Colombia, in which over 23,000 people lost their lives, the primary mission of the disaster assistance program is to reduce eruption-caused fatalities and economic losses in developing countries.

At the request of host countries and working through the Office of Foreign Disaster Assistance, USGS scientists provide rapid-response volcano monitoring to determine the nature of volcanic unrest and assess possible consequences of eruptive activity. Since it began in 1986, the program has responded to 15 volcano crises in 13 countries, most notably the 1991 eruption of Mount Pinatubo in the Philippines.

In April 1991, following steam explosions and earthquakes at Mount Pinatubo, the program helped the Philippine Institute of Volcanology and Seismology to assess and forecast volcano hazards at Mount Pinatubo. Timely warnings issued by the team of Filipino and USGS volcanologists—combined with effective communications between the scientists, emergency-management officials, military commanders, and the public—enabled the safe evacuation of at least 58,000 people prior to the volcano's climactic eruption on June 15.

The successful response to the Mount Pinatubo eruption saved tens of thousands of lives and hundreds of millions of dollars worth of equipment. Since 1991, the program also has responded to volcano crises in Mexico, Indonesia, Zaire, Papua New Guinea, Cape Verde Islands, and Montserrat (British West Indies).

The international work conducted by the USGS Volcano Hazards Program not only helps people in other countries to get out of harm's way but also benefits US efforts in hazard mitigation. "We gain monitoring experience at active volcanoes that will help during future crises in the western US and Alaska," said **Marianne Guffanti**, Program Coordinator for Volcano Hazards. "And we collect important scientific data on eruption precursors that we can use to understand how US volcanoes work."

John Ewert is a volcanologist with the Volcano Disaster Assistance Program at the USGS Cascades Volcano Observatory in Vancouver, Washington.